WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

APPLICATION OF INTELLIGENT INFORMATION ELECTRIC POWER SYSTEMS TO INCREASE THE EFFICIENCY OF FUNCTIONING UNIFIED ELECTRIC POWER SYSTEM OF UZBEKISTAN

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Abstract

The article carried out a systematic analysis of the functioning of existing electric power systems. Based on the results of the system analysis, problems and shortcomings of the processes of functioning of electric power systems were identified, for the elimination of which the use of an intelligent information electric power system was proposed. In this work, the principles and requirements for the creation and application are formed, and the structure of the intelligent information electric power system is developed, which includes the subsystem of support, databases, knowledge and functional blocks, and tasks. Using the methods of system analysis and information processing, a block diagram of information support and a generalized information model of intelligent information electric power systems have been developed. This article also provides generalized goals for improving the efficiency of using the potential capabilities of the control object, the main functions in the formation and adoption of control decisions in intelligent information electric power systems.

Keywords: system analysis, model, intelligent, structure, problem, process, task, structure, function, information system, database.

I. INTRODUCTION

At present, in all developed countries of the world, great attention is paid to electric power systems that use the most modern equipment and technologies, measurement and control tools, which make it possible to ensure the reliability and efficiency of the operation of electric power systems at a higher level.

The Unified Electric Power System (UES) of Uzbekistan, created more than sixty years ago, is a unique organizational and technical facility, the structure and management of which is built according to a hierarchical principle, which ensured a balanced unity of generation, distribution and consumption of electricity in the territorial context to ensure the energy security of the regions and the possibility of intersystem exchange of power and energy flows in normal and emergency modes to improve the efficiency of the energy association. At the same time, it should be noted that the UES, which was created a long time ago, needs a serious modernization of fixed assets and renewal, both in terms of replacing almost 50% of physically and morally obsolete equipment, and in the application of new technologies and equipment, information and diagnostic systems. The restructuring of the electric power industry, the market conditions for the functioning of the electric power industry bring their own characteristics and problems. To solve these problems, it is necessary to create and use an intelligent information electric power system (IIES), which ensures a reduction in costs in the production and transmission of electricity, a decrease in the level of losses in the transport of heat and electricity, and optimization of the size and placement of reserve capacities. The use of the IIES in the energy sector and the reform of the national energy sector pose new important tasks for the development of the UES of the republic. Modernization of energy management will lead to the financial independence of the fuel and energy complexes, which is provided by funds received for the production and transportation of energy. With an increase in the number of enterprises of the fuel and energy complexes and a decrease in the size of each separately, in comparison with the pre-reform vertically integrated enterprises of the fuel and energy complexes, the risks and significance of management decisions increase significantly. The responsibility of enterprises of the fuel and energy complexes for their own energy consumption increases the importance of energy saving issues, reducing excess energy losses and improving the quality of energy metering systems. Modernization of equipment and improvement of information technologies require more focused attention to the formation of the scientific and technical policy of the enterprise of fuel and energy complexes [1].

II. FORMULATION OF THE PROBLEM

The implementation of the IIES concept implies a huge increase in the volume of information flows from various sources that generate the most heterogeneous data that require continuous processing and transmission between different applications in real time. It is clear that a powerful communications platform and sophisticated information technology are required to manage new volumes of energy data. The problem of energy conservation is one of the most actively studied in world science. The implementation of the concept of sustainable development, the global significance of which has been increasing in recent years, the popularization of its ideas and fundamental principles, necessitate more in-depth research in the field of energy efficiency in IIES. It becomes quite obvious that this direction needs to be studied multilaterally, since this is a complex task that requires the use of multidirectional scientific knowledge. The unifying platform for solving the problem of increasing energy efficiency in the IIES is research in the field of electric power system management, since only competent managerial methodological solutions can ensure the interaction of its technical, technological, production, economic, organizational, managerial, psychological, social and other aspects. Currently, research in this area is actively carried out by foreign and scientists. According to a systematic analysis of the literature, the management of the electric power system in the system of general enterprise management is proposed to be considered as a purposeful activity to achieve energy results by solving an interconnected set of tasks in the process of planning, organizing, motivating and controlling aimed at improving energy efficiency and reducing energy consumption by applying modern methods of rational use fuel and energy resources [2].

III. DESCRIPTION OF EXISTING METHODS

The construction of the IIES structure is primarily associated with the construction of a system model, in which both the traditional elements of the control system and the knowledge processing models implemented by the intelligent system should be defined. In an intelligent control system, new elements compared to a traditional control system are all intelligent transformations or knowledge management elements that are associated with the implementation of artificial intelligence, i.e. using technologies of expert systems, database, goals and knowledge, decision making, associative memory, fuzzy logic, semiotic networks, structural dynamics control, etc.
Let us consider in more detail the block diagram of the IIES, which is presented in Fig.1. In this figure, the input of the system is the information input block (IIB), designed to enter numerical data, text, and speech. Information at the input of the system can come (depending on the problem being solved) from the user, the external environment, the control object. Further, the input information goes directly to the database (DB) - a set of tables that store, as a rule, symbolic and numerical information about the objects of the subject area or a control information generation block (CIGB) [3].

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ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

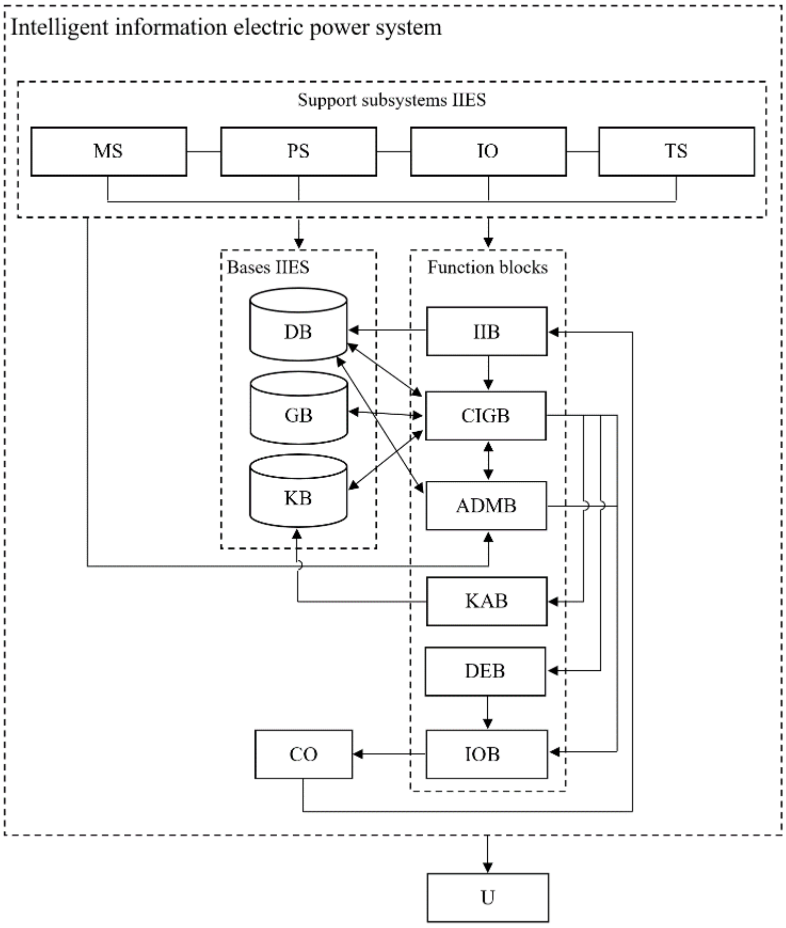

Fig. 1. Structural diagram of IIES

CIGB using database information, goal base (GB is a set of local goals of the system, which is a set of knowledge activated at a particular moment and in a particular situation to achieve a global goal) and a knowledge base (KB is a totality of knowledge, for example, a system of production rules, about the regularities of the subject area) provides solutions for the fuzzy formalized tasks of the IIES, and also carries out action planning and the formation of control information for the user or control object based on the database, knowledge base, business center and using a block of algorithmic decision methods (ADMB) contains algorithms, models and software modules for solving problems in the subject area. The knowledge assimilation block (KAB) analyzes dynamic knowledge in order to assimilate it and save it in the knowledge base. The Decision Explanation Block (DEB) interprets to the user the inference sequence applied to achieve the current result.

At the output of the system, the information inference block (IOB) provides the output of data, text, speech, images and other results of inference to the user (U) and / or the Control Object (CO).

ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

The feedback loop makes it possible to realize the adaptability and learning properties of the IIES. At the design stage, knowledge specialists fill the knowledge base and the goals base, and programmers develop programs modules based on algorithmic methods for solving problems. The database is created and updated, as a rule, during the operation of the IIES. The dynamics of the IIES operation can be described as follows. When information in the external language of the system is received at the input of the IIB, it is interpreted into an internal representation to work with the symbolic model of the system. The CIGB selects from the KB a set of rules activated by the received input information, and places these rules in the GB as the current goals of the system. Further, the CIGB, according to a given strategy, for example, the strategy of maximum reliability, selects a rule from the GB and tries to complete the definition of the variables of the model of the external world and the executive system with the control object. Based on this, new KB rules are activated and logical inference begins in the system of productions (rules). This procedure ends as soon as a solution is found, or when the GB is exhausted. The solution found from the internal representation is interpreted by the IOB into the external language of the lower-level control subsystem and the CO [4, 5].

In modern conditions, when making managerial decisions, the role of predictive information is increasing. The multi-criteria nature of decision-making tasks, the lack of a rigorous mathematical model describing the behavior of the UES in the time context, the lack of a complete amount of information and its possible unreliability lead to the fact that management decisions are often based on the experience and intuition of the manager. A tool is needed to improve the objectivity and quality of decisions made, using both the technical and economic indicators of the UES, and the experience of qualified specialists. In terms of information, the UES can be represented as a multi-level, multi-layer structure of a sufficiently large dimension with a complex multi-connected system of relations. To solve the problems of functioning and development of the UES, it is necessary to develop and implement an adequate information model. Such a model should be built on the basis of a multidimensional, hierarchical information system consisting of subsystems united by a set of functional links. It is these connections that make it possible to assess the functional state of subsystems and the system as a whole. In turn, the functional state of the UES is characterized by the following indicators: technical condition of power equipment, reliability of power supply, energy efficiency, environmental friendliness, financial stability, etc.

In domestic and foreign practice, attempts were made to resolve only certain aspects of the issues of creating a comprehensive information model for the functioning and

ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

development of the UES. In the current situation, in the absence of a single toolkit, it is impossible to solve the existing problems of managing the UES. That is why it is fundamentally necessary to create tools for monitoring power equipment and assessing the functional state of power equipment.

An information system that provides support for decision-making on the development and functioning of the UES must meet such an important requirement as the availability and reliability of the information used. This means that the models and decision-making methods used must be provided with information. The requirement of information security significantly affects the formation of mathematical models and methods used to solve energy problems. Part of the necessary information may be missing due to objective reasons related to the impossibility of obtaining it (lack of measuring systems, lack of communication channels, etc.). In addition, the lack of information is associated with the shortcomings of the information system of the enterprise of fuel and energy complexes, the fragmentation of its information subsystems, the lack of exchange between databases and software systems. (Fig. 2.).

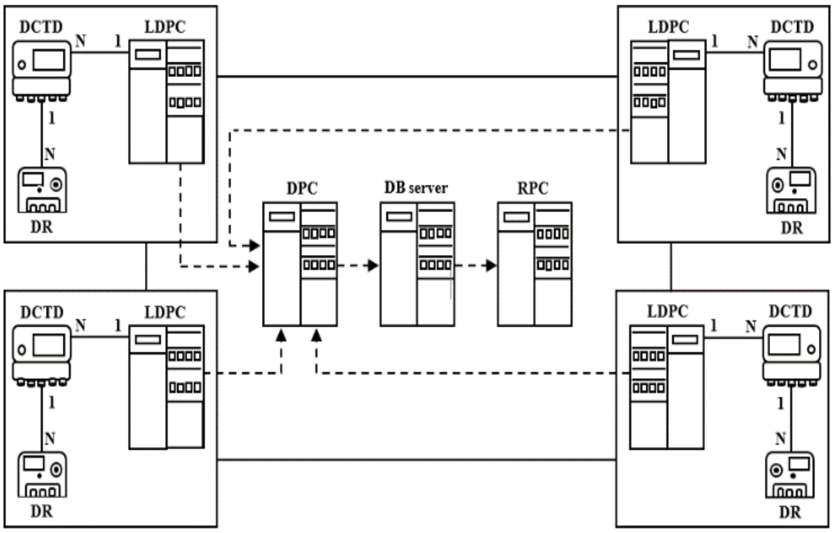

Fig.2. Exchange of information in IIES (data collection and transmission device, DCTD, local data processing center, LDPC, data recorder, DR, request processing center, RPC, database, DB)

Improving the quality of the decision-making system is associated both with the improvement of its information security, and with the development of mathematical methods of decision-making [7, 8].

Information support of the tasks of synthesis and operation of the UES is proposed to be considered based on the information model. Modern requirements for the presentation and use of information in the IIES make it expedient to use a new information technology - the so-called CIM - systems. Generalized information model

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ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

(Common Information Model - CIM) - further CIM - is a certain conceptual model for describing various objects (subjects) of the world, using object-oriented terminology. If until recent years the concepts of object-oriented technology were related to programming languages (C ++, Java, etc.), then CIM expands these concepts to describe data, deliberately using such terminology of object-oriented programming as classes, properties, methods and associations. In essence, CIM is an information model, the task of which is a single unified representation of data structures, regardless of the source of data origin and the purposes of their use (Fig. 3).

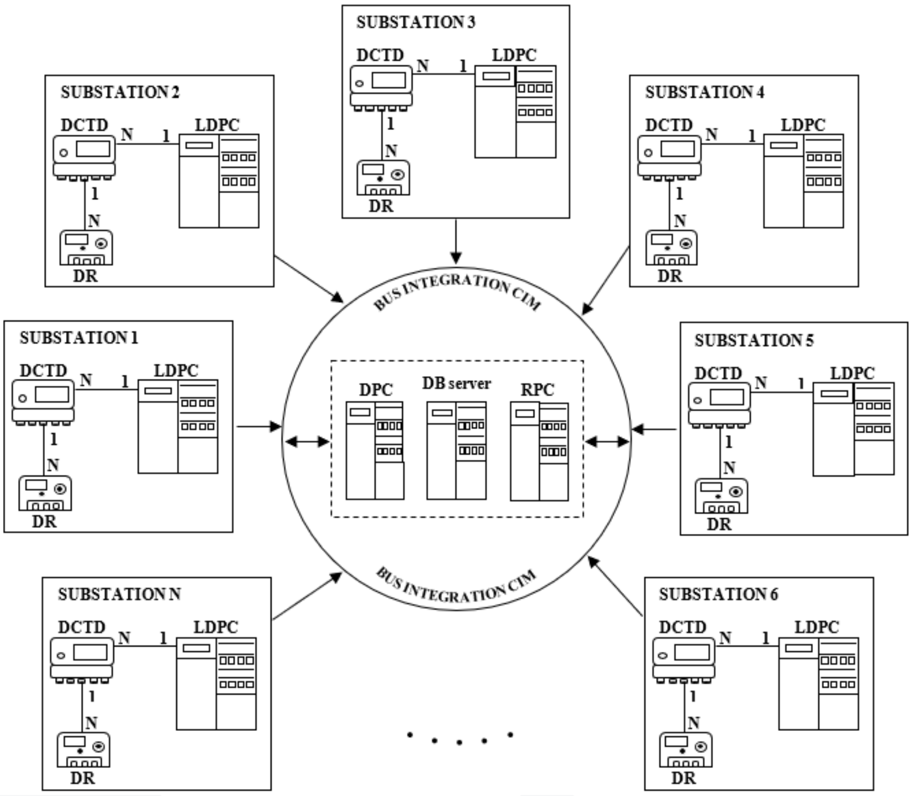

Fig.3. Relationship diagram when applying the CIM model in IIES

As already noted CIM - the model uses a standard object-oriented visual representation. The main elements of the CIM model are classes, associations, and packages. The class is the main element of the CIM model. A class is an abstract description of some objectively existing entity of an electric power system. Examples of classes are "transformer", "load", "ac line", "dc line", "measurement", etc. The fundamental difference between the concept of a class in CIM and object-oriented programming languages is that in CIM a class describes only an interface and is completely independent of both the computer technology platform and the implementation. The main properties of a class are encapsulation, polymorphism, and associations. Encapsulation means concentrating all the properties of a class as its

ISSN: 2776-0979, Volume 5, Issue 6, June - 2024

attributes within the class declaration. Polymorphism means that the same symbolic attribute name can be used in different classes, but the class name must be unique. Association means the possibility of connecting classes to each other, that is, any pair of classes can be connected by an association, which in turn is also a class. Associations represent a semantic relationship between two classes, with the help of which one class can obtain information about the attributes and associations of another class. An association has two association ends, each attached to one of the association classes. The end of an association may be marked with a label called "role name" or "role". In the CIM model, the role name almost always contains the class name, and in some cases simply repeats it. The end of the association (role) also has a multiplicity, which indicates how many objects of the class can participate in this association [6].

IV. EXPERIMENTAL RESULTS

In this work: - a new integration mechanism is considered for organizing information interaction of heterogeneous information systems of the UES - the so-called CIM-systems; - investigated the benefits of using such systems; - analyzed the methodology for building CIM models in relation to energy applications, as well as data access interfaces in CIM systems.

In the future, work will be carried out to adapt international standards for CIM systems to the real UES, a number of methodological documents will be developed that determine the possibility, rules and techniques for building information models, for the first time CIM for interactive creation of information models.

In general, IIES can be viewed as a set of interrelated management processes and objects. The general purpose of the IIES is to increase the efficiency of using the potential capabilities of the control object. Thus, a number of goals can be distinguished: - providing the decision maker (DM) with relevant data for decision-making; - acceleration of data collection and processing operations; - reducing the number of decisions that the DM must make; - increasing the efficiency of management, the level of control and performance discipline; - reducing the costs of the DM for the implementation of auxiliary processes; - increasing the degree of validity of decisions made.

The main functions of the IIES in the formation and adoption of control decisions: - information processing functions (computing functions) - carry out accounting, control, storage, search, display, replication, transformation of the information form; - functions of exchange (transfer) of information - are associated with bringing the developed control actions to the CO and exchanging information with the DM; - decision-making functions (transformation of information content) - creation of new information in the course of analysis, forecasting or operational management of an object.

The main stages of the decision-making process according to the theory of decision-making are decomposed into the following stages:

- determination of the purpose of solving the problem;
- choice of the most preferred course of action leading to the achievement of the goal;
- implementation of the solution (chosen variant of action).

Determining the goal of solving the problem that has arisen is implemented in the intelligent converter unit, which receives and processes information about the external environment from the sensor system. In conflict situations, the goal may depend on the available resources and factors that form a problematic situation, i.e. decision-making in conflict situations. The method of action for controlling an object in the decision-making process is called strategies, and the result that the chosen strategy can lead to is called the outcome. Conflict conditions give rise to factors that affect the strategy and, accordingly, the control implemented by the intelligent system. Depending on the origin, uncertain factors are divided into random and uncertain non-stochastic nature, consisting of natural and strategic ones.

The mathematical model of decision-making is formed taking into account all the factors and the information available about them. A simplified decision-making model in this case can be described by the following system

$$Pr = \langle I, M, U, L, J, O \rangle \quad (1)$$

where I is the set of outcomes (results); M - model of preferences for outcomes (decisions made); U - many decision strategies; L - many possible values of uncertain factors; J - a function that determines the relationship of an uncertain factor and the outcome resulting from the decision; O - all other information about the decision being made in a formalized form (information about the conflict, preferences of other persons participating in the conflict, etc.) [9, 11].

The convenience of using model (1) in a conflict is determined by the fact that it allows you to simply and clearly connect the values of uncertain factors and strategies with the control implemented by an intelligent system. The sets I, M, U, L and the function J formally define the components of the decision being made and determine the connection with the control system through the concepts of the criterion and system performance indicators. In management theory, preference relations are most often described using special functions of quality indicators and criteria. An indicator of the quality or effectiveness of a management system is a measure of the degree to which the real result of management corresponds to the one required to achieve the goal and obtain estimates or measurements of the intensity of outcomes. A criterion is a rule that makes it possible to compare decisions and strategies made in terms of selected indicators of outcome assessments. Criteria are introduced on the basis of a certain concept of rational behavior of an intelligent system: suitability, optimization and adaptability.

V. CONCLUSIONS

To solve the above tasks, you must first perform the following work:

1. Create a system of industry standards for building unified information models for both the UES as a whole and its individual elements.
2. Create a system of industry standards that describe a unified system of application-level interfaces and provide application integration.
3. To create in the IIES a network environment of a common information bus that supports a single information model focused on WEB-services technology and allows creating applied heterogeneous systems based on the same platform-independent network technologies.
4. To create the necessary organizational "vertical" structure of the IIES, supporting the unity of information models and interface models for all market participants.

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